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J. A. AILEO

3,335,720

VALVE FOR SOUND ATTENUATING DEVICE

Filed June 2, 1965

2 Sheets-Sheet 1

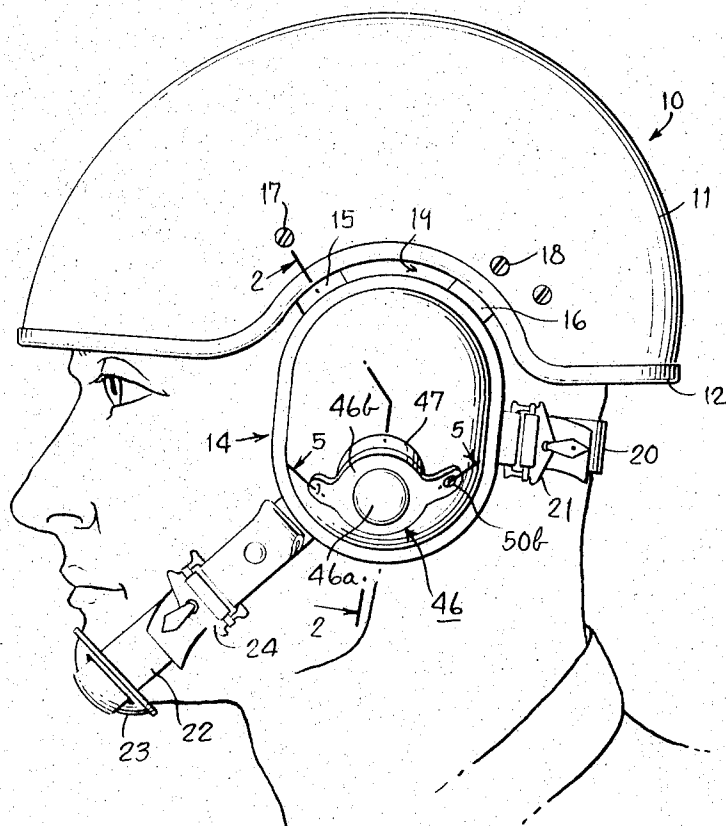


Fig. 1.

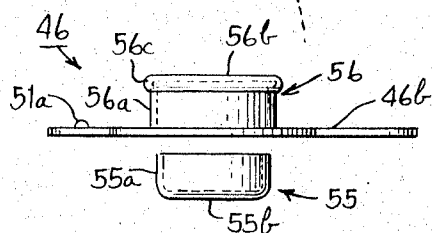


Fig. 4.

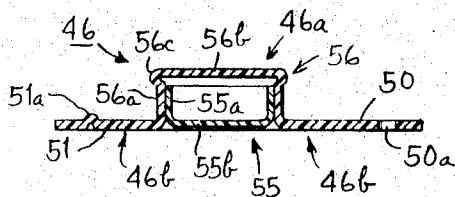


Fig. 5.

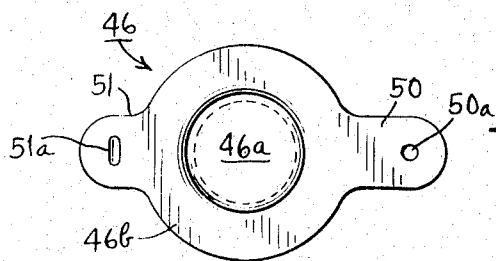


Fig. 3.

INVENTOR

JACKSON A. AILEO

BY

Lester H. Clark

ATTORNEY

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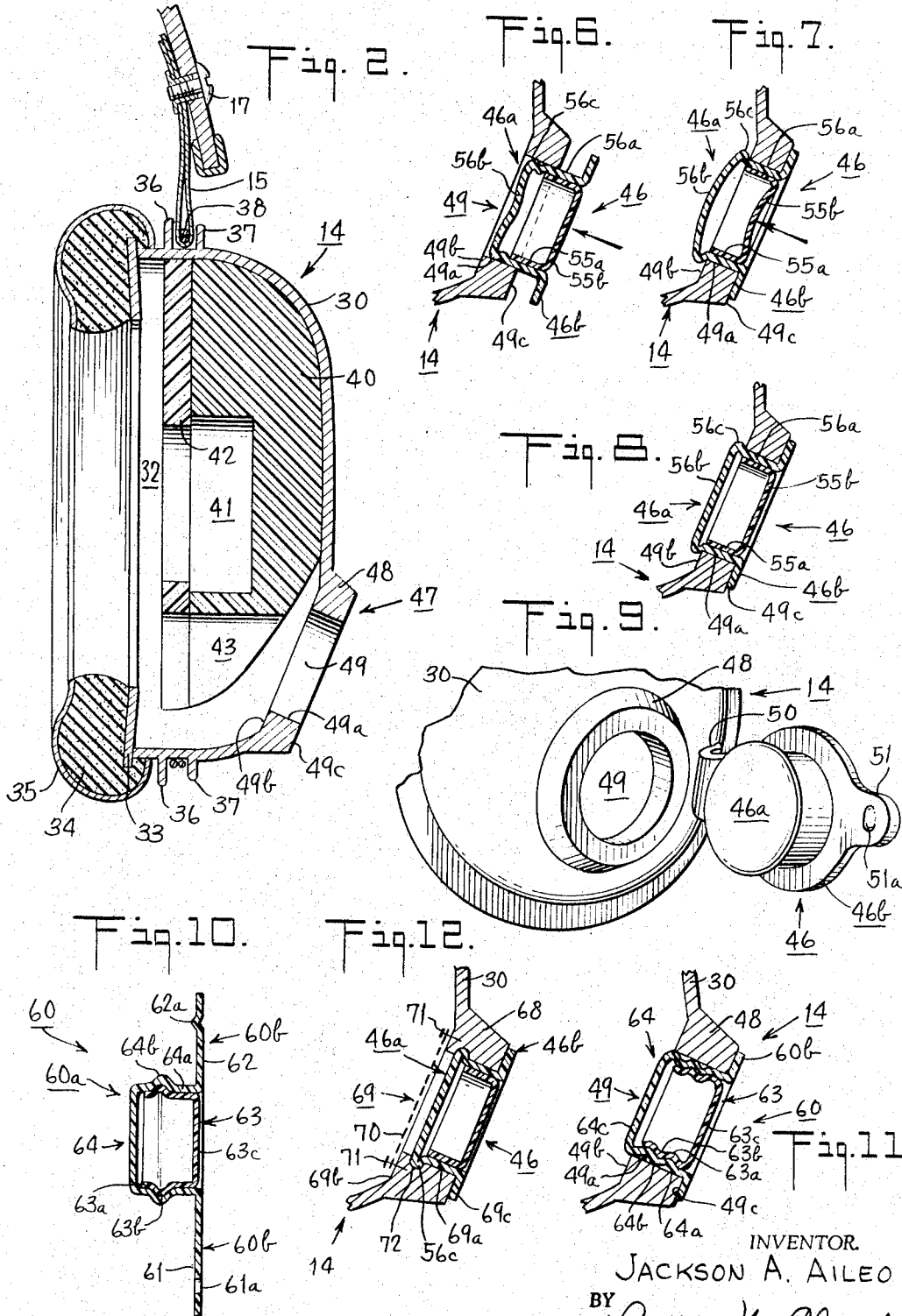
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2 Sheets-Sheet 2



INVENTOR
JACKSON A. AILEO
BY *Lester H. Clark*
ATTORNEY

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VALVE FOR SOUND ATTENUATING DEVICE
Jackson A. Aileo, Carbondale, Pa., assignor to Leonard
Peter Frieder, Carbondale, Pa., a corporation of Penn-
sylvania

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15 Claims. (Cl. 128—152)

ABSTRACT OF THE DISCLOSURE

A sound attenuating ear cup suitable for employment in very high sound intensity environments, including means for opening and closing a physical path for sound communication from the exterior to the interior of the ear cup, characterized by an aperture leading from the exterior to the interior of the ear cup for providing such a sound path, a valve means which can be fitted into the aperture to completely close it off, the valve means having sound attenuating properties approximately equal to that of the ear cup so that when inserted into the aperture the sound path is completely removed, and movable means connecting the valve means and the ear cup so that the valve means can be located completely within the aperture to close off sound communication or completely outside the aperture to open the sound communication path, so that the two conditions can be readily tactually discriminated by the wearer, all to the purpose of preventing the wearer from thinking that he is in a low sound intensity environment when indeed he is in a high sound intensity environment and does not know it because the valve means is in place within the aperture preventing him from realizing that a high intensity sound environment exists. With the present invention the wearer is prevented from damaging his hearing by his mistake in such a situation because he can readily tactually determine by very simply touching of his hand to his ear cup whether or not the valve means is in place, and therefore whether or not he is in a low sound environment or merely seems to be because the valve member is in place.

Background of the invention

It is desirable to protect the ears of persons who are required to work in the vicinity of machines producing intense noises. The problem is particularly acute among personnel required to work in the vicinity of jet aircraft. In order to provide such protection, it has been proposed to provide sound attenuating housing structures, commonly called ear cups, which are typically rigid shells and to mount those structures on a helmet, a head-band, or the like, so that they may be held fixed in place over the wearer's ears.

Each of the sound attenuating devices of this type must be made of sufficiently large dimensions to ensure that the entire ear of the wearer is enclosed, and to provide sufficient interior space within the device for receiving sound absorbing material to afford adequate protection from high intensity sounds. In addition, a telephone receiver usually is incorporated within at least one of a pair of ear cups to provide a means of communicating with the wearer when the sound attenuating device is in its engaged position about the wearer's ear, closing off acoustical transmission between the wearer's ear and the atmosphere.

It has been proposed to provide, in the shell of one or both of the sound attenuating devices, a valve which the wearer may adjust selectively to an open position to permit aural communication therethrough, without necessitating the removal of the devices from their engaged positions about the wearer's ears, and to a closed position to provide the desired sound attenuation.

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A sound attenuating device including such a valve is shown in my copending application for United States Letters Patent, Ser. No. 29,026, filed May 13, 1960. Each of the sound attenuation devices disclosed therein comprises a hollow member, such as a rigid shell, adjustably mounted on a helmet and adapted to enclose the ear of the wearer of the helmet. The rigid shell comprises a wall extending about a space within the shell and defining the continuous periphery of an opening at one side of the space. A ring formed of sponge rubber or other resilient material extends along the periphery of the opening for engaging the head of the wearer of the helmet. The valve comprises a plurality of apertures in the wall of the shell and a rotatable disc having a corresponding plurality of apertures. The disc is mounted on the rigid shell and is adapted for selective rotation to an open position in which the apertures therein are aligned with respectively associated apertures in the rigid shell to permit aural communication through the latter, and to closed position in which the apertures in the rigid shell are blocked by the solid or unapertured portions of the disc, thus closing off acoustical transmission through the apertures in the rigid shell.

Although the valve of my copending application provides the desired selection between closed and opened positions, certain difficulties accompany its use. In particular, it is somewhat difficult for the wearer to determine quickly by the sense of touch, whether the disc is rotated to a position aligning the apertures and opening the valve, or to a position blocking the apertures and closing the valve. This inability to determine the open or closed position of the valve may be very detrimental, such as where the wearer of the sound attenuation cup is in an area of high intensity sound. The wearer may become confused by the intensity of the sound reaching his ears through the ear cups and, thinking that the valve is open, rotate the disc, intending to close the apertures, but inadvertently aligning the apertures and permitting sound transmission therethrough. Depending upon the degree of intensity of the ambient sound, the inadvertent opening of the valve may result in injury to the wearer. Where the wearer is required to wear gloves or other hand protective devices, the operation of the valve and the tactual determination of its open or closed position becomes increasingly difficult.

It is therefore an object of this invention to provide a valve for a sound attenuating device which enables the wearer thereof readily to determine tactually its open or closed position. Another object is to provide such a device in which such a tactual determination of the open or closed position of the valve is made as a normal and natural part of the manual movement of the valve between its open and closed positions.

A further object of this invention is to provide a valve for a sound attenuating device having improved sound attenuation characteristics in its closed condition.

Still a further object of this invention is to provide a valve for a sound attenuation device which is low in cost and easy to manufacture and which provides a high degree of sound attenuation in its closed position.

Brief description of the invention

In accordance with a preferred embodiment of the invention, the sound attenuating device includes a hollow member such as the ear cup of my above-described copending application. An improved valve is carried by the hollow member and is operable between an open position to establish communication through the ear cup and thus to the ear of the wearer of the device and a closed position to attenuate acoustical transmission through the ear cup from the atmosphere. The valve includes valve seat

means comprising a cylindrical aperture in the shell wall and the inner and outer marginal surfaces of the shell wall surrounding the aperture. The valve means also includes a valve plug formed of a resilient, non-porous material, and having a sealed drum and a flange. The drum comprises a hollow cylinder closed at its inner and outer ends by interior and exterior diaphragms, respectively, a radially projecting rim joining the interior diaphragm to the cylinder. The drum defines an enclosed chamber which may be filled with a fluent, sound-absorbing material. The flange is joined to the outer end of the drum and includes a first tab providing a flexible hinge for connecting the valve plug to the shell in all positions of the valve plug and a second tab, diametrically opposite the first tab, which may be grasped for changing the position of the valve plug. To close the valve, the drum is inserted in a snug fit within the aperture with the flange engaging the outer surface of the cup. By applying an inwardly directed force to the exterior diaphragm, such as by the wearer pushing against the exterior diaphragm with his finger, the interior diaphragm is distended and moves inwardly of the cup, drawing the radial rim inwardly. Upon removal of the finger and termination of the force, the diaphragms retract and the rim is drawn into snug engagement with the margin of the inner surface of the cup. The rim overlaps the juncture of the drum cylinder and the aperture-defining surface of the cup and provides further sealing of the aperture for attenuating acoustical transmission therethrough. To permit aural communication through the aperture, the second tab of the flange is grasped and the drum portion of the valve is removed from the aperture, the valve plug being suspended in hinged fashion from the shell by the first tab of the flange.

By a quick tactual inspection, the wearer of the helmet may determine that the valve plug is removed from the aperture and suspended from the cup, and thus that the valve is in its open position; conversely, the flush relationship of the flange of the valve plug with the outer surface of the cup when the valve is closed enables the wearer readily to determine the closed position of the valve. Furthermore, such a tactual inspection is a necessary and natural preliminary to any manual change in the valve position.

Other objects and features of the invention will be understood from the description to follow of the drawings, in which:

FIG. 1 shows in side elevation a helmet supporting a sound attenuation device incorporating the valve means of the invention, in place on the head of a wearer;

FIG. 2 is a section on line 2—2 of FIG. 1 showing a cross-section of the sound attenuation device, the means for suspension thereof from the helmet shell, and the valve seat means with the valve plug removed;

FIG. 3 is an enlarged elevational view showing the valve plug of the invention as shown in FIG. 1;

FIG. 4 shows an exploded plan view of the valve plug of the invention;

FIG. 5 is a section view taken along the arcuate line 5—5 of FIG. 1, showing the valve plug of the invention;

FIGS. 6 to 8 are sections on a portion of the line 2—2 of FIG. 1, showing the valve seat means and the valve plug of the invention in three positions during the seating of the valve plug;

FIG. 9 is a fragmentary perspective view showing the valve means of the invention in open position with the valve plug removed from the valve seat means; and

FIG. 10 shows a second embodiment of the valve plug of the invention in a section therethrough similar to the section of FIG. 5;

FIG. 11 shows the valve plug of FIG. 10 in a section therethrough similar to the section of FIG. 8; and

FIG. 12 shows a second embodiment of the valve of the invention in a section therethrough similar to the section of FIG. 8.

FIGURES 1 TO 9

In FIG. 1 is shown a helmet 10 having a rigid shell 11 of suitable material and having an opening on the lower side thereof for receiving the head of the wearer. The shell 11 is defined by an edge 12 disposed at a level somewhat above the eyes and the nape of the neck. The shell is supported in its position on the head by rigging and head-band means (not shown).

A pair of ear cups 14 (only one of which is shown) is provided on opposite sides of the helmet 10 and suspended therefrom by suitable means, such as straps 15 and 16, the latter being secured to the shell 11 by screws 17 and 18, respectively. The edge 12 of the shell extends about bays 19 formed in the shell 11 to accommodate the ear cups 14. A nape strap 20, having a buckle arrangement 21 to provide length adjustment, connects the pair of ear cups 14 and extends across the nape of the neck. A chin strap 22 having a chin cup 23 engaging the chin of the wearer and a buckle arrangement 24 to provide length adjustment also extends between the pair of ear cups 14 to secure them in position about the ears' of the wearer.

Referring concurrently to FIGS. 1 and 2, the ear cup 14 comprises a wall 30 extending about a hollow space 32 therewithin and defining the continuous periphery of an opening at one side of the space 32. An annular flange 33 extends in a radial direction, both inwardly and outwardly, from the wall 30 about the periphery of the space 32. A ring 34 of resilient material, such as sponge rubber, is fixed to the flange 33 and includes an outer cover 35 of leather, of suitable pliant material, for engaging the head of the wearer. The ring 34 is of any suitable configuration providing both comfort for the wearer and a tight acoustical connection to the wearer's head, permitting communication between the ear of the wearer and the hollow space 32 but closing off communication between the ear of the wearer and the atmosphere surrounding the ear cup 14.

A pair of annular flanges 36 and 37 extend radially about the periphery of the wall 30 of the ear cup 14 and confine an endless cord 38 therebetween. Straps 15, 16, 20 and 22 (only strap 15 appearing in FIG. 2) are looped about the endless cord 38 and secured thereby to the ear cup 14. The ear cup 14 may be rotated relative to the straps and the endless cord 38 to a position affording the greatest comfort and closest engagement thereof with the head of each individual wearer to provide the desired sound sealing relationship.

Disposed within the space 32 and suitably secured to the interior of the wall 30 is a body 40 of resilient sound absorbing material. The body 40 includes interior walls defining a pocket 41 within which suitable telephonic equipment, e.g., a receiver, may be received. A retaining layer 42 of similar material as the body 40 is positioned in contiguous relationship therewith and is provided with an aperture communicating with the pocket 41. An edge portion of the layer 42 overlies the pocket 41 to secure the telephonic equipment in position. Portions of the body 40 and the layer 42 are removed to provide an interior passageway 43 communicating between the hollow space 32 and the valve of the invention.

The valve of the invention includes a valve plug 46 and a valve seat means 47; the valve plug 46 is not shown in FIG. 2 to enable illustrating the valve seat means 47 more clearly. The valve seat means 47 is provided in a cylindrical boss 48 which is joined in a flaring fashion to the wall 30. An aperture 49 is centrally disposed in, and extends through the boss 48; the aperture 49 and the passageway 43 provide a path for communication from the atmosphere and through the ear cup 14 to the space 32 adjacent the ear of the wearer. The valve seat means 47 includes the cylindrical surface 49a, defining the aperture 49, and the inner and outer surfaces 49b and 49c, respectively, of the boss 48 of wall 30 which surround the aperture 49.

The valve plug 46 is shown on an enlarged scale in

FIG. 3, reference being had concurrently to FIGS. 1 to 3. The valve plug 46 is movable into and out of aperture 49 to provide the closed and open positions, respectively, of the valve of the invention. The valve plug 47 is made of a resilient, non-porous material, such as plastic, and includes a sealed drum 46a and a flange 46b. When the valve is closed (see FIG. 8), the drum 46a fits snugly within the aperture 49 and the flange 46b abuts against the outer surface 49c of the boss 48. The flange 46b includes a first tab 50 having an aperture 50a therein for receiving a screw 50b to secure the valve plug 46 to the ear cup 14. The first tab 50 provides a flexible hinge for connecting the valve plug 46 in all positions thereof to the ear cup 14. The flange 46b further includes a second tab 51 diametrically opposite the first tab 50 and having a rib 51a therein, the rib 51a facilitating grasping of the second tab 51 for moving the valve plug 46 between the open and closed positions of the valve.

Preferably the valve plug 46 is manufactured by telescoping an inner cup 55 within an outer cup 56, as illustrated in the exploded view of FIG. 4. The inner cup 55 has a cylindrical wall 55a closed at its outer end by a diaphragm 55b. The outer cup 56 has a cylindrical wall 56a closed at its inner end by a diaphragm 56b. A radially projecting rim 56c joins the diaphragm 56b to the cylindrical wall 56a. The flange 46b is formed integrally with the outer end of the outer cup. Cup 55 fits snugly within cup 56 and the walls 55a and 56a are sealed together by heat sealing or bonding at their circumferential interface for at least a short axial extent adjacent their inner ends, defining a sealed chamber within drum 46a.

The drum 46a filled with a fluent material, i.e., a gas, a liquid or a particulate solid. Preferably, the fluent material is one having sound absorbing properties, e.g., lead oxide. The fluent material, however, preferably is selected so as not to impede flexing or slight distorting of the interior and exterior diaphragms 56b and 55b. The distorting of the diaphragms 56b and 55b is advantageous in the closing of the valve, as discussed below, and is permitted due to the resiliency of the diaphragms. The cylindrical wall of the drum 46a, due to its double thickness provided by the cylindrical walls 55a and 56a, is less subject to distorting than the diaphragm in accordance with the requirements of the valve. If desired, the walls 55a and 56a may be made slightly thicker than their associated diaphragms 55b and 56b, respectively, to increase the relatively greater stiffness of the cylindrical wall of the drum.

FIGS. 6 to 8 show three positions of the valve plug 46 as it is seated in the valve seat means 47 for closing the valve. The drum 46a is inserted within the aperture 49, the cylindrical wall 49a depressing the radial rim 56c radially inwardly and slightly distorting the interior diaphragm 56b. The valve plug 46 is pushed inwardly to bring the flange 46b into tight engagement with the outer surface 49c surrounding the aperture 49, as shown in FIG. 7. The wearer applies an inwardly directed force to the exterior diaphragm 55b, as by pushing inwardly thereon with his finger, causing the exterior diaphragm 55b to be depressed inwardly. Since the drum 46a is sealed and defines an enclosed chamber therein, the pressure applied to the exterior diaphragm 55b is transmitted through the fluent material with the drum 46a and is exerted against the interior diaphragm 56b, causing it to distend or bulge inwardly and to move the rim 56c inwardly of the inner wall surface 49b.

As shown in FIG. 8, upon removal of the wearer's finger and, consequently, termination of the force applied to the exterior diaphragm 55b, the latter retracts to approximately its normal, generally planar configuration. The interior diaphragm 56b also retracts and draws the rim 56c into tight, sealing relationship with the inner wall surface 49b.

The exterior diameter of the drum 46a is made approximately equal to that of the aperture 49 such that a tight sealing fit is secured between the cylindrical wall of the drum 46a and the cylindrical wall surface 49a. If desired, the surface 49a and the cylindrical wall of the drum may each include a slight, corresponding taper in an inward, axial direction, such that a wedge fit is secured therebetween. The axial length of the cylindrical wall of the drum 46a is made approximately equal to the axial length of the cylindrical surface 49a of the aperture 49 such that the radial rim 56c and the flange 46b tightly engage the inner and outer wall surfaces 49b and 49c, respectively, and provide a seal overlapping the juncture between the cylindrical wall of the drum and the surface 49a to assist in attenuating acoustical transmission through the aperture 49.

To open the valve, the second tab 51 is grasped and pulled outwardly, removing the drum 46a from within the aperture 49. As shown in FIG. 9, the first tab 50 provides a flexible hinge for movably connecting the valve plug 46 to the ear cup 14 in all positions of the valve, the valve plug 46 being suspended from the wall 30 of the ear cup 14 in the open position of the valve.

The suspended or hanging position of the valve plug 46 is readily ascertainable by a tactual inspection by the wearer and enables him to determine immediately that the valve of the invention is in its open position. Conversely, the flush relationship of the flange 46b of the valve plug 46 with the surface 49c likewise is readily ascertainable by a tactual inspection, enabling the wearer to determine that the valve is closed. The tactual inspection is particularly effective since changing the position of the valve means between its opened and closed conditions requires, in any event, a manual grasping of the valve.

Thus, when the wearer is in a region of high intensity sound, the positive determination of the closed position of the valve means of the invention, afforded by the tactual inspection, will prevent him from erroneously thinking that the valve means is open. With prior art forms of the valves, such an erroneous determination may easily occur with the result that the wearer, intending to close the valve may instead open it, and subject himself to injury from the high intensity sound.

FIGURES 10 AND 11

A second embodiment of a valve plug suitable for use in accordance with the invention is shown in FIGS. 10 and 11. Valve plug 60 includes a drum 60a and a flange 60b, the latter including a first tab 61 having an aperture 61a for receiving securing means to secure the valve plug 60 to an ear cup 14. The flange 60b further includes a second tab 62, diametrically opposite the tab 61 and having a rib 62a for facilitating grasping of the flange 60b for moving the valve plug 60 between open and closed positions.

The sealed drum 60a preferably is made by telescoping a first or inner cup 63 within an outer cup 64. The inner cup 63 includes a cylindrical sidewall 63a having a radial protrusion 63b about the circumference thereof, and a diaphragm 63c closing one end of the cup. The outer cup 64 includes a cylindrical sidewall 64a having a radial protrusion 64b about the circumference thereof and a diaphragm 64c closing the inner end of the cup 64. The cup 63 is telescoped within the cup 64 with the radial protrusions 63b and 64b in mating relationship, the cylindrical walls 63a and 64a being sealed together to define a closed chamber within the sealed drum 60a. The radial protrusions 63b and 64b form a radial protrusion about the circumference of the cylindrical wall of the drum, intermediate the inner and outer ends thereof. The enclosed chamber within the drum 60a preferably is filled with a fluent sound absorbing material, such as hereinbefore described with reference to the valve plug 46.

The valve plug 60 is employed with a valve seating

means identical to that of the foregoing figures, identical elements being indicated by identical numerals. The valve plug 60 is inserted into the aperture 49, to bring the flange 60b into tight engagement with the outer surface 49c surrounding the aperture 49. The radial protrusion provided in the cylindrical wall of the drum 60a has a diameter slightly greater than that of the aperture 49 and therefore tightly engages the cylindrical surface 49a. The radial protrusion is forced or compressed radially inwardly by the surface 49a, distorting the axially adjacent portions of the cylindrical wall of the drum 60a. The portions of the cylindrical wall axially displaced from either side of the radial protrusion maintain the cylindrical configuration and remain in sealing engagement with the cylindrical surface 49c and, in conjunction with the engagement of the radial protrusion therewith, provide a tight, sound-sealing fitting of the drum 60a within the aperture 49 to attenuate acoustic transmission there-through.

The axial length of the drum 60a relative to that of the aperture 49 is not critical; however, it is preferable that the relative axial lengths be such that radial protrusion and the portions of the cylindrical wall of the drum 60a axially displaced in either direction from the protrusion engage the surface 49c to assure a sealing relationship therebetween in the closed position of the valve. In addition, the flange 60b engages the outer surface 49c when the valve is closed and overlaps the juncture between the drum 60a and the surface 49a to assist in attenuating acoustic transmission through the aperture 49.

FIGURE 12

In FIG. 12 there is shown a further embodiment of the invention having valve seat means including a generally cylindrical boss 68 joined in a flaring fashion to a wall 30 of an ear cup. An aperture 69 is disposed centrally in the boss 68 and provides a passageway for aural communication through the wall 30. The valve seat means includes an annular recess 72 in the surface 69a which defines the aperture 69. The annular recess 72 is coaxial with the aperture 69 and is located intermediate the inner and outer surfaces 69b and 69c, respectively, of the wall 30.

A screen 70 extends across the inner end of the aperture 69 and is secured to the inner surface 69b of the wall 30 surrounding the aperture 69 by securing means, such as pins 71. The screen 70 is formed of any suitable material which readily permits of acoustical transmission therethrough but which is sufficiently strong to withstand inadvertent puncture or destruction. Preferably, the screen is made of a fine wire mesh. The screen 70 serves to prevent foreign objects, such as insects or dirt, from entering the interior of the ear cup when the valve is in its open position, thereby protecting the ears of the wearer from such objects.

A valve plug 46 which is identical to the valve plug of FIGS. 1 to 9 and therefore is identified in FIG. 12 by identical numerals, is received within the aperture 69 in the closed position of the valve to attenuate acoustical transmission therethrough. The axial length of the cylinder of the drum portion 46b is made approximately equal to the axial length of the aperture 69 along the surface 69a intermediate the recess 72 and the outer surface 69c.

In moving the valve to its closed position, the drum 46b is inserted into the aperture 69 to bring the flange 46a into engagement with the outer surface 69c. An inwardly directed force is applied to the exterior diaphragm 55b, such as by the wearer pushing inwardly thereon with his finger. The inwardly directed force is transmitted through the sealed drum and distends the interior diaphragm 56b, moving it inwardly and drawing the radial rim 56c inwardly, causing the latter to seat within the annular recess 72. Upon removal of the finger and termination of the force, the interior and exterior diaphragms 56b and 55b contract to approximately the normal, planar

configuration as shown, drawing the radial rim 56c outwardly and into sealing engagement with the annular recess 72. The radial rim 56c and the flange 46a overlap the juncture between the cylindrical wall of the drum 46b and the surface 49a and assist in attenuating acoustical transmission through the aperture 49 in the closed position of the valve.

The use of a screen extending across the inner end of an aperture in an ear cup is highly desirable, for the reasons pointed out above. Such a screen may be employed in all of the embodiments of the invention, with appropriate modifications of the screen or the valve seat and the valve plug. For example, for use with the valve of FIGS. 1 to 9, a screen may be fixed to an annular mounting ring of greater interior diameter than the exterior diameter of the rim 56c. The ring would be secured to the inner surface 49b coaxially about the aperture 49 and extend into the ear cup with the screen fixed to the inner end of the ring. By mounting the screen in this manner, a space of sufficient axial and radial extent is provided for proper closing and seating of the valve plug 46, with the rim 56c engaging the inner surface 49b, as shown in FIGS. 6 to 8.

The valve shown in FIGS. 10 and 11 is readily adaptable to the use of a screen mounted across the inner end of the aperture. In accordance with a first construction, since the valve plug 60 does not engage the inner surface 49b, the screen may be mounted to the inner end of a ring having the same interior diameter as the aperture 49. As an alternative construction, the axial length of the valve plug 60 may be made less than that of the aperture 49, whereby the screen may be fixed directly to the inner surface 49b. In either construction, sufficient space is obtained for proper seating of the valve plug in the closed position of the valve.

A significant advantage of the valve means of the invention over the valve means taught by the prior art relates to the ease with which the wearer may determine the opened or closed condition of the valve means. By a quick manual inspection, the wearer may readily ascertain that the valve plug is hanging freely from the ear cup and thus that aural communication through the orifice is occurring. Conversely, when the valve plug is received within the orifice, closing off communication therethrough, the flush relationship of the flange portion of the plug with the boss may likewise readily be determined. Furthermore, such determinations of the valve position are necessarily made by a wearer operating the valve in the normal manner, as a part of that operation. Nevertheless, the wearer may actually determine the valve position quickly and without opening or closing it. Thus, the wearer will not inadvertently open the valve, intended to close it.

Such inadvertent operation may easily occur with the valves shown and taught in the prior art, with resultant extreme danger to the wearer when he is in a high intensity sound level area.

In summary, the valve means of the invention provides both a very effective sound attenuating seal while nevertheless being very easy to operate between its closed and open positions and permitting of a quick and simple manual inspection to ascertain its position at any given time.

Numerous modifications and adaptations of the valve plug of the invention will readily be apparent to those skilled in the art. Thus, it is intended by the appended claims to cover all such modifications and adaptations as fall within the true spirit and scope of the appended claims.

What I claim is:

1. A sound attenuating device comprising:

(a) an ear cup adapted to receive an ear of a wearer and having an aperture spaced from the rim of said cup, said aperture when open provides a sound path

- from the exterior of the ear cup to the interior of the ear cup so that sounds existing outside the ear cup are transmitted to the ear of the wearer;
- (b) a valve movable between a closed position within said aperture and an open position completely outside said aperture, and said valve having sound attenuating properties at least equal to those of said ear cup so that the presence of said valve within said aperture prevents the access of sound from outside said ear cup into the interior of said ear cup as regards said aperture; and
- (c) means movably connecting said valve to said ear cup in all positions of said valve.
2. A sound attenuating device as recited in claim 1 wherein said valve comprises:
- (a) a drum;
- (b) a flange joined to the outer end of said drum; and
- (c) said drum being received in said aperture and said flange engaging the outer surface of said ear cup in said closed position of said valve.
3. A sound attenuating device as recited in claim 2 wherein:
- (a) said drum defines an enclosed chamber therein; and
- (b) said chamber in said drum is filled with a fluent sound absorbing material.
4. A sound attenuating device as recited in claim 3 wherein said fluent sound absorbing material is lead oxide.
5. A sound attenuating device comprising:
- (a) an ear cup adapted to receive the ear of a wearer and having an aperture spaced from the rim of the cup, said aperture when open provides a sound path from the exterior of the ear cup to the interior of the ear cup so that sounds existing outside the ear cup are transmitted to the ear of the wearer;
- (b) a valve movable between a closed position within said aperture and an open position completely outside said aperture, and said valve having sound attenuating properties at least equal to those of said ear cup so that the presence of said valve within said aperture prevents the access of sound from outside said ear cup into the interior of said ear cup as regards said aperture; and
- (c) said valve including a flange abutting the exterior surface of said ear cup in said closed position of said valve; and
- (d) said flange including a flexible hinge portion for connecting said valve to said ear cup in all positions of said valve.
6. A sound attenuating device as recited in claim 5, wherein said flange includes graspable means for moving said valve between said closed and open positions.
7. A sound attenuating device as recited in claim 5 wherein:
- (a) said flange portion includes a first tab and a second tab diametrically opposite said first tab;
- (b) said first tab providing said flexible hinge portion for connecting said valve to said ear cup in all positions of said valve; and
- (c) said second tab comprising said graspable means for moving said valve between said closed and open positions.
8. A sound attenuating device as recited in claim 7 wherein said second tab includes a rib projecting transversely from the surface thereof to facilitate grasping of said second tab.
9. A sound attenuating device comprising:
- (a) an ear cup adapted to receive the ear of a wearer;
- (b) valve means associated with said ear cup and movable between a closed position for attenuating acoustic transmission through said ear cup and an open position which is readily tactually distinguishable from the closed position for transmitting sound communication through said ear cup;
- (c) said valve means including valve seat means com-

- prising an aperture in said cup, spaced from the rim of said cup, and the outer surface of the wall of said cup surrounding said aperture;
- (d) said valve means further including a valve plug having a sealed drum and a flange joined to the outer end of said drum, said drum being receivable within said aperture with said flange engaging said outer surface to provide said closed position of said valve means and said drum being removable from within said aperture to provide said open position of said valve means.
10. A sound attenuating device as recited in claim 9 wherein:
- (a) said valve seat means further includes the inner surface of said wall of said cup surrounding said aperture; and
- (b) said drum includes a radially extending rim adjacent the inner end thereof for engaging said inner surface in said closed position of said valve means.
11. A sound attenuating device as recited in claim 9 wherein:
- (a) said valve seating means further includes the inner surface of said wall of said cup surrounding said aperture;
- (b) said drum includes a hollow cylinder, a radially extending rim, and interior and exterior diaphragms, said interior diaphragm being joined to the inner end of said hollow cylinder by said radially projecting rim and said exterior diaphragm being joined to the outer end of said hollow cylinder to define an enclosed chamber therein;
- (c) said interior and exterior diaphragms and said rim being formed of resilient material; and
- (d) in closing said valve, said interior diaphragm distending inwardly of said cup in response to application of an inwardly directed force to said exterior diaphragm to move said rim inwardly of the inner surface of said ear cup, and said interior and exterior diaphragms contracting upon termination of said force to draw said rim into engagement with said inner surface of said wall of said cup.
12. A sound attenuating device as recited in claim 9 wherein said drum includes a hollow cylinder having a radial protrusion extending about the circumference thereof of intermediate the ends of said cylinder.
13. A sound attenuating device as recited in claim 9 wherein there is further provided a screen element extending across the inner end of said aperture.
14. A sound attenuating device as recited in claim 9 wherein:
- (a) said drum includes a radially extending rim adjacent the inner end thereof,
- (b) said aperture includes a coaxial annular recess in the wall of said cup intermediate the inner and outer surfaces thereof; and
- (c) said rim of said drum is received in said annular recess and said flange engages said outer surface in said closed position of said valve means.
15. A sound attenuating device comprising:
- (a) an ear cup adapted to receive an ear of a wearer and having an aperture spaced from the rim of said cup;
- (b) a valve movable between a closed position within said aperture and an open position which is readily tactually distinguishable from the closed position, said valve including a drum and a flange;
- (c) said drum is formed from an inner and an outer cup;
- (d) each of said inner and outer cups including a cylindrical wall and a diaphragm, one diaphragm being joined to the inner end of said hollow cylinder of said outer cup and the other diaphragm being joined to the outer end of said hollow cylinder of said inner cup;
- (e) said inner cup being telescoped within said outer

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cup and said hollow cylinders of said inner and outer cups being joined together to define an enclosed chamber within said drum; and
(f) said flange being joined to the outer end of said outer cup and including means movably connecting said valve to said ear cup in all positions of said valve.

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ADELE M. EAGER, *Primary Examiner*.

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,335,720

August 15, 1967

Jackson A. Aileo

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 4, line 31, for "of" , second occurrence, read --
or --.

Signed and sealed this 13th day of August 1968.

(SEAL)

Attest:

Edward M. Fletcher, Jr.

Attesting Officer

EDWARD J. BRENNER

Commissioner of Patents